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Water Quality and Streamflow in the Caribou-Poker Creeks Research Watershed, Central Alaska, 1978

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Abstract

Baseline data from 1978 are presented on precipitation, streamflow, and chemical and biological water quality in a subarctic, taiga watershed. First-, second-, and third-order streams that drain undisturbed catchments embracing permafrost-underlain and permafrost-free landscapes were monitored; results are being used in analysis of the natural, undisturbed condition of the research watershed.

Keywords: Water quality, stream environment, streamflow, stream analysis, subarctic environment, watershed management, hydrology, taiga, Alaska.

Introduction

Study sites embracing representative ecosystems and amenable to observation, measurement, and experimentation are valuable for developing basic understanding of environmental properties and processes, as well as for developing and testing techniques for resource management. For such a research site to be most useful, baseline site information such as stream flow regime, local climate, and stream quality must be available. This report presents basic data and initial analyses for undisturbed streams within a formally established, subarctic environmental-research site.

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Objectives

Baseline data on water quality from four monitoring stations in the Caribou-Poker Creeks Research Watershed were acquired during a segment of the 1978 summer (open-water) season. Weekly field sampling was conducted on two first-order streams, one second-order stream, and one third-order stream. The two first-order streams were chosen because they differ in proportion of permafrost (permanently frozen ground). The stream draining a permafrost-dominated basin was expected to have a more pronounced response to storm events, resulting in greater discharge peaks, higher turbidity and sediment production, and lower water temperatures than a relatively permafrost-free watershed. The third-order stream was expected to have higher annual discharge and higher turbidity, sediment production, and water temperatures than the second-order stream.

A weekly schedule for water-quality sampling was adopted, to evaluate applicability of that schedule to monitoring storm events during the ice-free season. Discharge characteristics of the streams were compared to determine whether a more intensive, storm-oriented sampling scheme would be necessary for adequate monitoring of sediment production during high flows.

Results of this partial-season study provide a basis for more intensive investigations of stream quality. This information is being used to develop a better understanding of the current environmental functioning of the site, and in planning for experimental manipulation of selected landscapes.

The Study Area

The Caribou-Poker Creeks Research Watershed (fig. 1) encompasses 106 km^2 in the subarctic taiga of central Alaska.[1] The research watershed, 49 km north of Fairbanks, was established in 1969 under sponsorship of the Inter-Agency Hydrology Committee for Alaska (formerly Inter-Agency Technical Committee for Alaska).

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[1]The Institute of Northern Forestry currently administers two other major field study areas: Bonanza Creek Experimental Forest and Washington Creek Fire Study Area.

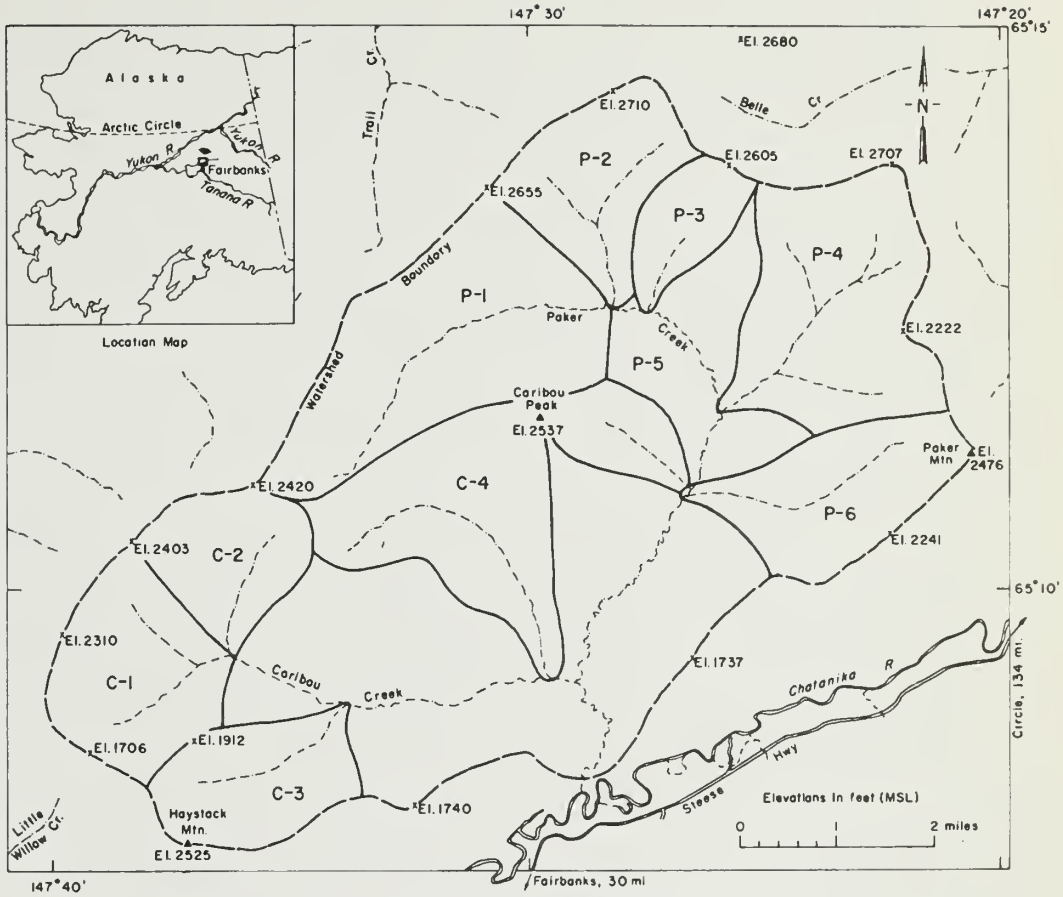

Figure 1.--Caribou-Poker Creeks Research Watershed.

The dendritic drainage pattern of Caribou and Poker Creeks is developed in the Precambrian Birch Creek schist of the Yukon-Tanana Uplands (Wahrhaftig 1965). The watershed has moderate relief, with elevations from 210 m above mean sea level (m.s.l.) to 826 m above m.s.l., and is almost entirely forested. Vegetation patterns are typical of the discontinuous-permafrost taiga; valleys and north-facing slopes are underlain by permafrost and support slow-growing stands of black spruce (Picea mariana (Mill.) B.S.P.) and a deep, virtually continuous organic ground cover (sphagnum and feather mosses, as well as accumulated litter). South-facing slopes are generally free from permafrost and support heterogeneous and sometimes almost pure stands of birch (Betula papyrifera Marsh.), aspen (Populus tremuloides Michx.), white spruce (Picea glauca (Moench) Voss), and alder (Alnus crispa Ait.) Pursh. Streamside zones are commonly dominated by a shrub complex of dwarf birch (Betula glandulosa Michx.), willow (Salix spp.), blueberry (Vaccinium uliginosum L.), and associated species.

The climate is typically continental with short, warm summers (May through mid-September) and long, cold winters. Precipitation is low, averaging about 50 cm/year at upper elevations (compared with 29 cm/year at Fairbanks). Winter snowfall has averaged 17.5 cm (water equivalent) over the past 7 years.

Most effort so far in Caribou-Poker Creeks has been to establish and maintain sites for acquiring hydrologic and climatologic data. Shifting agency responsibilities, funding, and personnel has produced discontinuities in the basic data set. With designation in 1977 of the research watershed as an Experimental Ecological Reserve (Institute of Ecology 1977), renewed emphasis has been placed on reliable, long-term environmental monitoring; this report of baseline data in part reflects that emphasis.

We also decided in 1977 to place greater emphasis on analysis of upland stream systems, particularly the physical, chemical, and biological quality of undisturbed first- and second-order streams draining permafrost and nonpermafrost catchments. This report includes recent data on stream quality, building on earlier water-quality sampling by Jinkinson et al. (1973) and Lotspeich et al. (1976). Biological characteristics of the watershed will be addressed in a subsequent report.

A general description of the study area and objectives is given by Slaughter and Lotspeich (1977). More specific information is available for many aspects of Caribou-Poker Creeks Research Watershed, including geology (Koutz and Slaughter 1972), soils (Reiger et al. 1972), vegetation (Vogel and Slaughter 1972; Troth et al. 1975, 1976), and hydrology (Carlson 1972, Ford 1973, Kane and Slaughter 1973, Slaughter and Long 1974, Santeford 1978). Several earlier reports of basic hydrometeorology data are also available (Slaughter 1970a, 1970b, 1972; Hobgood and Slaughter 1974; Lotspeich et al. 1976; Bredthauer 1977; Slaughter and Bredthauer 1977).

Methods

Precipitation

Summer precipitation was measured at the confluence of Caribou and Poker Creeks with a Weather-Measure tipping-bucket precipitation gage (Model P-501), linked to a Weather-Measure event recorder (Model P-522). At three sites (Helmers Ridge, and at the 487- and 640-m elevations on the Caribou Peak trail), precipitation was measured with Fisher-Porter weighing precipitation gages (Model 1559). A large storage gage equipped with a Leupold & Stevens A-71 level recorder was used to measure precipitation on Caribou Peak at 768 m. Snowfall data will be reported in another paper.

Streamflow

Streamflow data for Caribou and Poker Creeks (CJ and PJ) were acquired by personnel of the U.S. Geological Survey (1979), using water-level recorders at natural-control cross sections. Streamflow from subdrainage C2 was monitored with a Fisher-Porter 1542 water-level recorder with a fiberglass Parshall flume. Streamflow from subdrainage C3 was measured with a similar flume, equipped with a Leupold & Stevens Type F water-level recorder.

Water Quality

Four primary stream-sampling stations were established for the 1978 summer and fall field season. All sampling was conducted near midday, and we tried to sample all the stations in as short a time as access and travel allowed. No more than 3 hours elapsed between the first and last station sampling. Each station was sampled weekly for chemical constituents. Two 125-ml samples were taken and filtered through Gelman microquartz glass fiber filters (0.45 μm). Samples for Na, K, Ca, Mg, As, Fe, and Mn were acidified to pH 2 and stored in the dark at 5°C until analyzed by atomic absorption spectrophotometry (American Public Health Association 1975). Samples for NO_2, $NO_2 + NO_3$, NH_3, PO_4, and Si were filtered as above, stored frozen, and later analyzed with a Technicon Auto-Analyzer (U.S. Environmental Protection Agency 1976). A 500-ml sample was collected and filtered through a tared Gelman microquartz glass fiber filter (0.45 μm) for quantification of nonfilterable residue (suspended sediment) (American Public Health Association 1975).

Ambient air and water temperature, turbidity, pH, and alkalinity were measured by portable field apparatus on the sites. Specific conductance was measured with a calibrated Beckman Solubridge meter.

Biological sampling for macroinvertebrate populations (tri-replicate Surber sampling at nine stations), and preliminary evalution of periphyton sampling methods for analysis of standing-crop biomass and accumulation rates on various artificial substrates will be presented in a separate publication.

Subdrainages C2 and C3 were chosen for detailed monitoring because they differ in occurrence of permafrost. The proportion of permafrost was determined from soil maps (Reiger et al. 1972). The C2 catchment is predominantly nonpermafrost (only 3 percent by area) and is characterized by south-facing slopes, with relatively deep soils supporting aspen, paper birch, white spruce, and some black spruce. The C3 subbasin has a greater proportion of permafrost (53 percent by area) than C2 because of its generally northeast aspect. Soils are shallow, overlain by a moss/lichen ground cover and generally open overstory dominated by black spruce (Slaughter and Kane 1979). Striking dissimilarities in local climate (Slaughter and Long 1974) and hydrologic response between the two subdrainages have been documented.

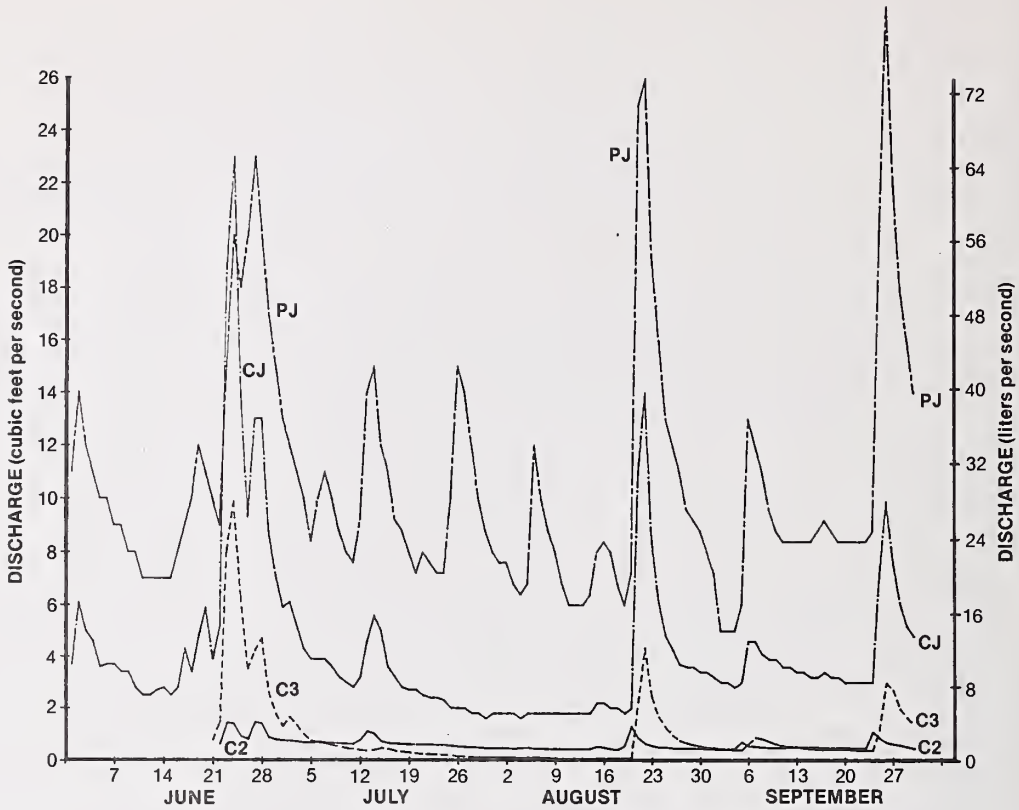

Figure 2.--Summer 1978 hydrographs of C2, C3, CJ (Caribou Creek), and PJ (Poker Creek).

Results and Discussion

Hydrology

Precipitation data for the ice-free season of 1978 are given in appendix tables 9 and 10. Mean daily streamflow data for the four stations are summarized in appendix tables 11 through 14. Hydrographs from all four stations over the ice-free season are presented as figure 2. Poker Creek exhibited higher flows than Caribou Creek throughout the season. Of special interest in the subarctic is a comparison of the response to summer storms of a stream draining a permafrost-dominated basin (C3) with a stream draining a relatively permafrost-free basin (C2). Cumulative precipitation measured at the junction of Poker and Caribou Creeks is compared hourly with C2 and C3 hydrographs for storms that occurred in June, August, and September 1978 (figs. 3, 4, and 5). Response in all three events was much more pronounced in C3 (permafrost-dominated) than in C2 (comparatively permafrost-free).

Figure 3.--Hydrographs of C2 and C3 and cumulative storm precipitation at junction of Poker and Caribou Creeks, June 22 to July 1, 1978.

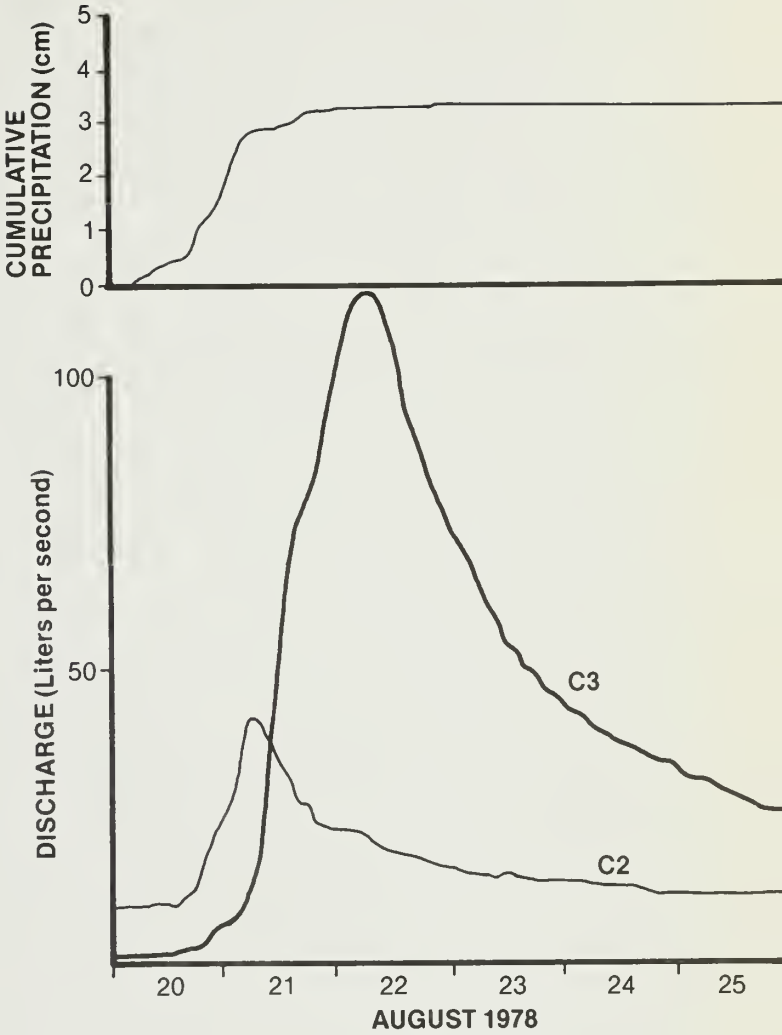

Figure 4.--Hydrographs of C2 and C3 and cumulative storm precipitation at junction of Poker and Caribou Creeks, August 20 to 25, 1978.

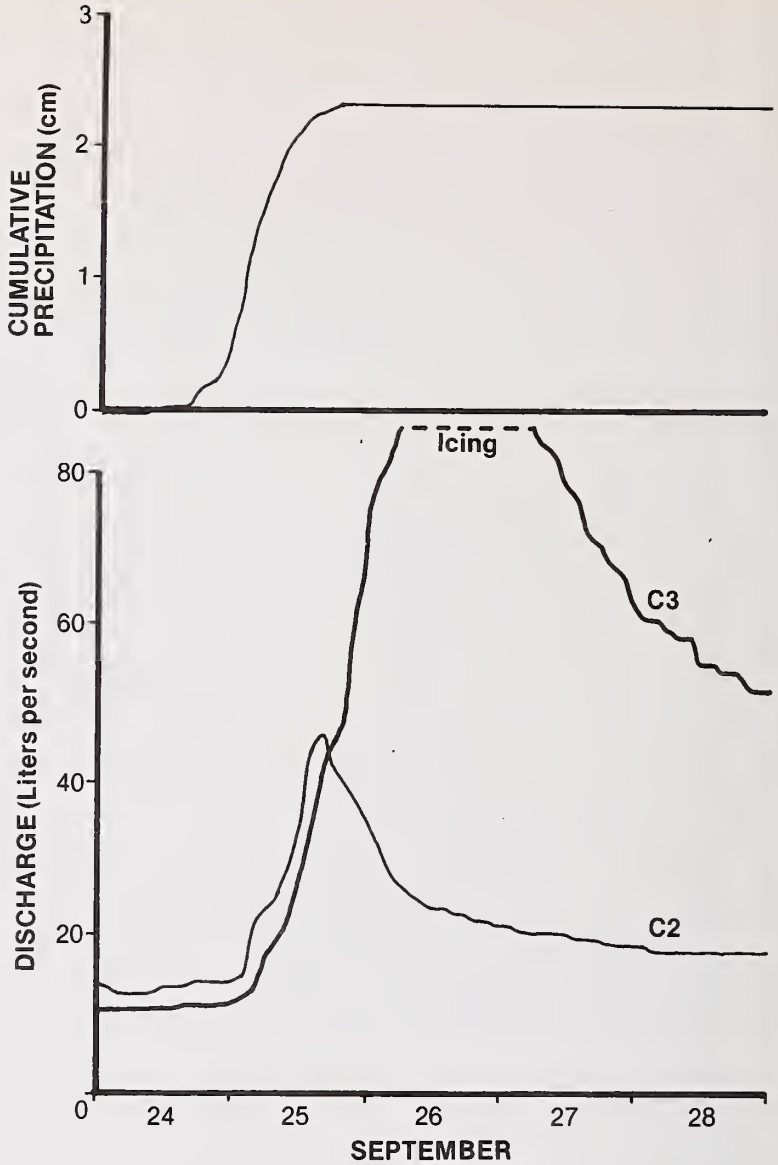

Figure 5.--Hydrographs of C2 and C3 and cumulative precipitation at junction of Poker and Caribou Creeks, September 24 to 28, 1978.

Water Quality

Physical and chemical characteristics (air and water temperature, pH, alkalinity, and specific conductance) are presented in appendix table 15. Concentrations of nonfilterable residue, turbidity, and point discharge are given in appendix table 16.

Water temperatures appeared slightly lower in the C3 (permafrost-dominated) drainage than in the C2 (low-permafrost) drainage. Mean temperatures (based on weekly point measurements) for the ice-free study period (7-26 through 9-28) were 3.2°C in C3 and 4.25°C in C2. Mean water temperatures (weekly point measurements) for the ice-free period were 3.5°C for Caribou Creek and 4.9°C for Poker Creek, possibly reflecting higher mean water temperatures with increasing drainage area.

Figure 6 shows weekly sampling-time water temperatures at the four stations and midday air temperature at the confluence of Poker and Caribou Creeks.

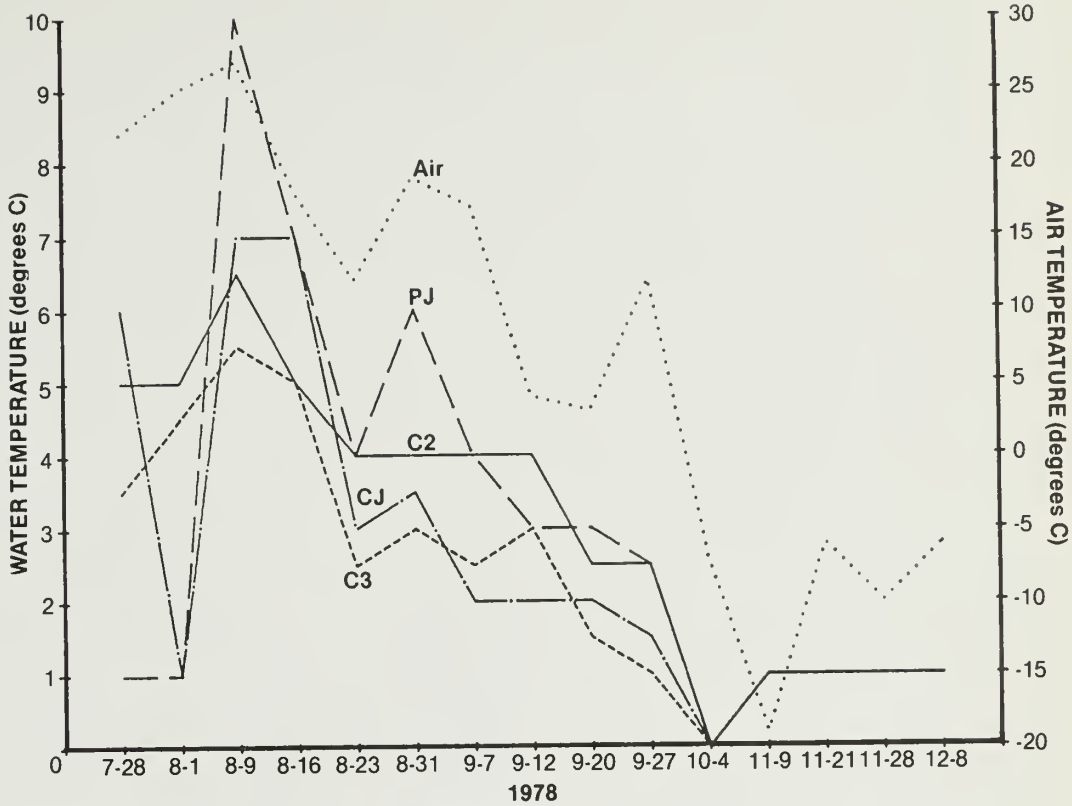

Figure 6.--Air and water temperatures in Caribou-Poker Creeks.

The mean values of nonfilterable residue (measured weekly) for the period 5-16-78 to 10-4-78 (fig. 7) were 0.24 mg/l for C2 (N=21) and 0.23 mg/l for C3 (N=20); standard deviations were 0.42 (C2) and 0.41 (C3). A t-test for the difference of the two means indicated no significant difference ($P>0.05$). Nonfilterable residues for the period 6-21-78 through 12-8-78 (fig. 8) were higher in Poker Creek (PJ), with a mean of 10.66 mg/l (N=32), than in Caribou Creek (CJ), with a mean of 3.64 mg/l (N=31). Standard deviations were 14.19 (PJ) and 10.86 (CJ). A t-test indicated a significant difference between the means of CJ and PJ ($P<0.05$).

Mean turbidity values for weekly samples from 7-26-78 through 10-4-78 (N=11) were 2.18 Formazin turbidity units (FTU) in C2 (standard deviation = 3.03) and 2.09 FTU in C3 (standard deviation = 2.26). Mean turbidity values for weekly samples from 7-26-78 through 12-8-78 (N=15) were 5.40 FTU in Caribou Creek (standard deviation = 5.08) and 4.73 FTU in Poker Creek (standard deviation = 3.59). The t-tests revealed no significant difference ($P>0.05$) between the means of C2 and C3 and likewise no significant difference ($P>0.05$) between the means of CJ and PJ. Relation of turbidity to discharge for C2 and C3, and CJ and PJ are presented in figures 9 and 10.

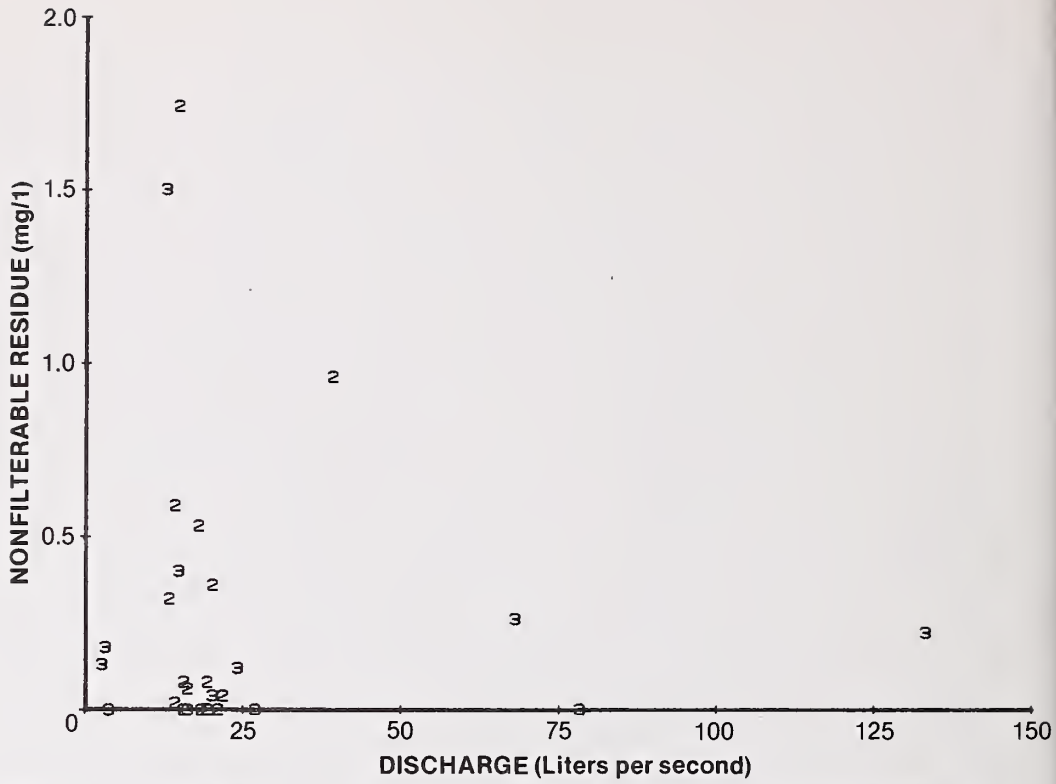

Figure 7.--Relation of nonfilterable residue to discharge, C2 (2) and C3 (3).

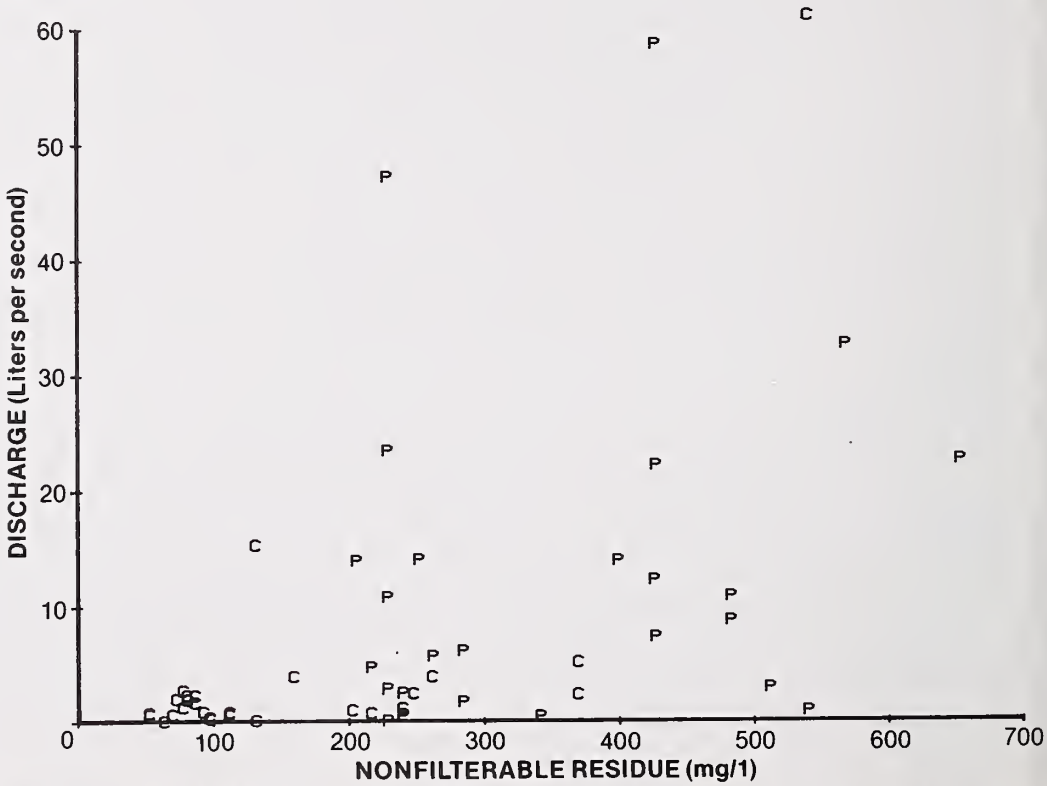

Figure 8.--Relation of nonfilterable residue to discharge, Caribou (CJ) and Poker (PJ) Creeks.

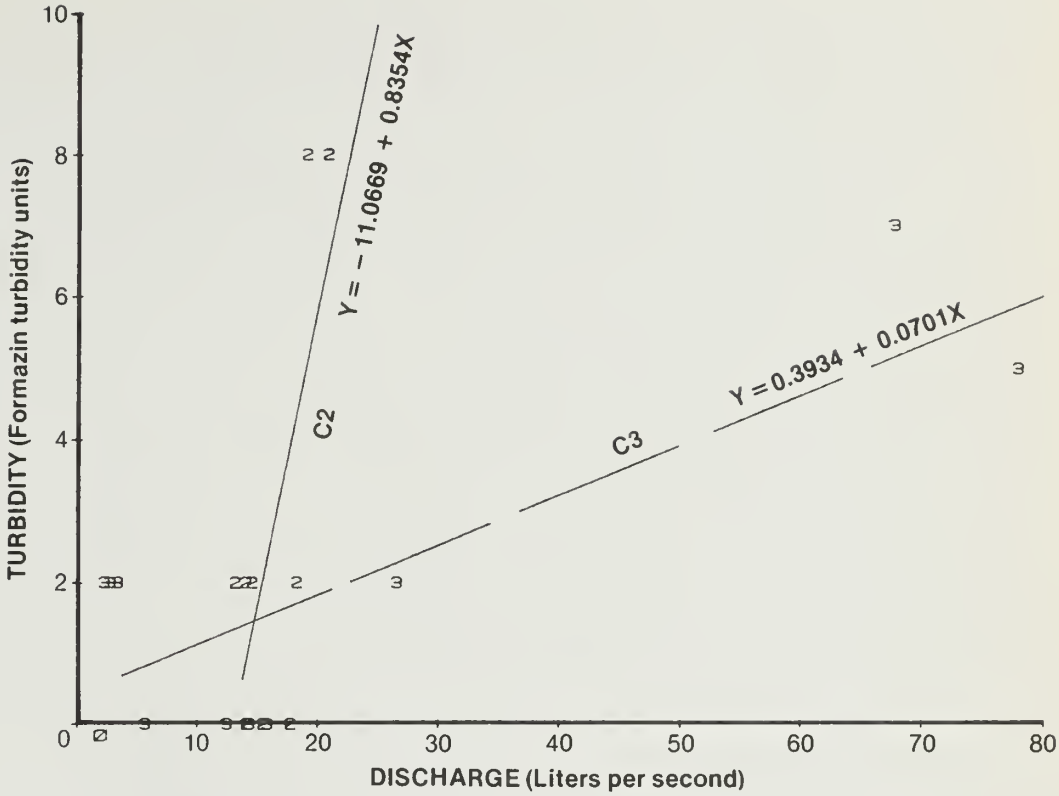

Figure 9.--Relation of turbidity to discharge in C2 and C3.

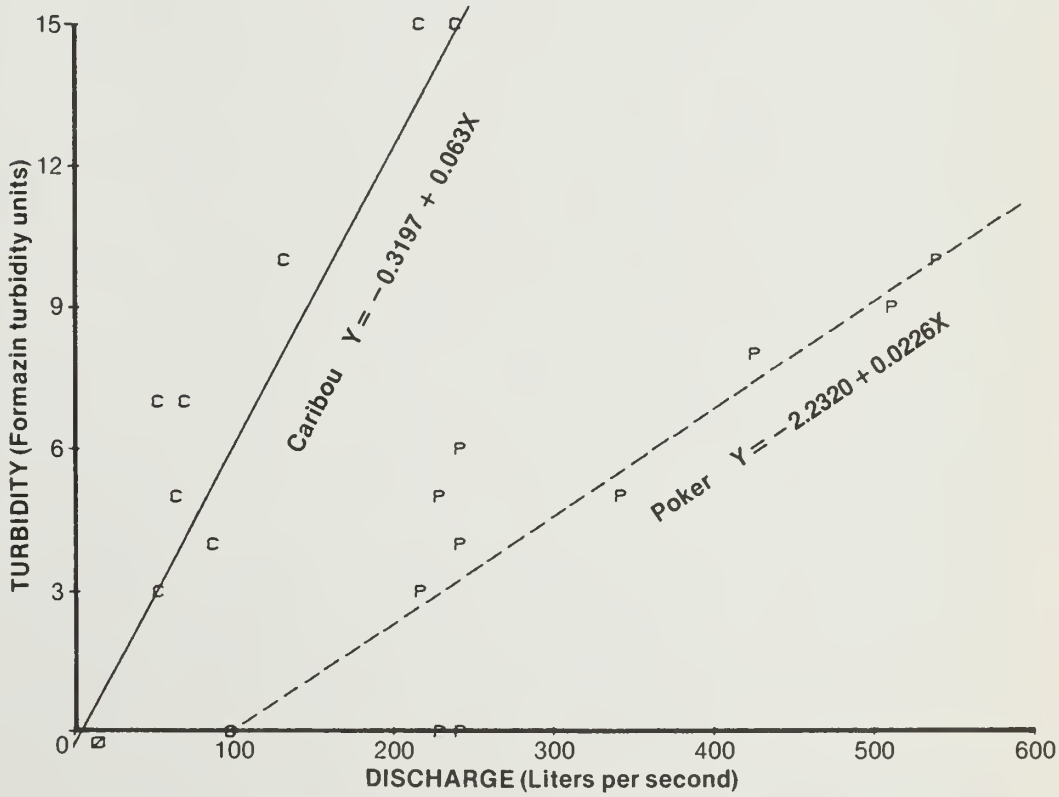

Figure 10.--Relation of turbidity to discharge in Caribou (C) and Poker (P) Creeks.

Calculated correlation coefficients among discharge, nonfilterable residue, turbidity, and water temperature are listed in table 1.

Table 1--Correlation coefficients for 4 stream-sampling stations, Caribou-Poker Creeks Research Watershed

Station	Correlation coefficient	Sample size
Turbidity to discharge:		
C2	0.693*	10
C3	.325	10
CJ	.780*	10
PJ	.833*	10
Nonfilterable residue to discharge:		
C2	0.189	15
C3	-.165	14
CJ	.672*	27
PJ	-.077	26
Nonfilterable residue to turbidity:		
C2	-.116	11
C3	-.295	11
CJ	.205	15
PJ	.300	15
Water temperature to discharge:		
C2	.361	10
C3	.690*	10
CJ	-.436	7
PJ	-.416	7

* = significant at the 5-percent level.

Turbidity generally was significantly correlated ($P<0.05$) with discharge. Only the permafrost-dominated C3 basin did not exhibit this correlation. Nonfilterable residue (suspended sediment) generally was not significantly correlated with discharge; only the Caribou Creek (CJ) samples showed a significant correlation ($P<0.05$) between these parameters.

Turbidity was not significantly correlated ($P>0.05$) with nonfilterable residue at any of the stations sampled. This may be attributed to heavy loadings of organic leachates (often referred to as "tea-colored water") into low-order streams during high-flow periods. Such loadings can increase turbidity without increase in associated sediment concentrations in the stream. Development of a predictive residue:turbidity regression is precluded, when few samples are collected during a single season and concentration of suspended sediment is low.

Based on these preliminary data and others using infrequent sampling, predicting concentration of nonfilterable residues by using turbidity or streamflow for these streams would not be justified.

Failure of the permafrost-dominated C3 basin to show strong correlation between discharge and turbidity may be related to temperature and ground cover (reflections of the microclimate of colder, north-facing slopes). Permafrost-underlain landscapes have cold soils, typically overlain by thick, virtually continuous organic mats that may be highly acidic (pH as low as 3.5). Leaching processes and rates that affect the input of lignins and tannins into streams may thus differ markedly from warmer settings. Such stream responses, if characteristic of permafrost-dominated catchments, should "average out" as water is progressively incorporated into higher order channels downstream, reflective of a composite of varying permafrost/non-permafrost conditions.

Mean values of alkalinity, pH, and specific conductance are summarized in tables 2, 3, and 4. Mean pH values appeared slightly higher in the two main creeks (7.8) than in the two first-order streams (7.6). Specific conductance, pH, and bicarbonate alkalinity appeared to increase slightly during periods of early winter ice cover and reduced discharge.

A listing of concentrations of nitrogen, phosphorus, and silicon is presented as appendix table 17.

Table 2--Mean alkalinity of 4 streams, Caribou-Poker Creeks Research Watershed

Station	Season (1978)		
	Open-water (7-26 to 10-5) (N=11)	Ice-cover (11-9 to 12-9) (N=4)	Total (7-26 to 12-9) (N=15)
	Milligrams per liter of bicarbonates		
C2	38.9	--	--
C3	29.1	--	--
CJ	47.1	52.5	49.1
PJ	55.7	64.0	58.7

Table 3--Mean pH of 4 streams, Caribou-Poker Creeks Research Watershed

Station	Season (1978)		
	Open-water (7-26 to 10-5) (N=11)	Ice-cover (11-9 to 12-9) (N=4)	Total (7-26 to 12-9) (N=15)
C2	7.76	--	--
C3	7.79	--	--
CJ	7.88	7.98	7.91
PJ	7.91	8.00	7.94

Table 4--Mean specific conductance of 4 streams, Caribou-Poker Creeks Research Watershed

Station	Season (1978) Open-water (7-26 to 10-5) (N=11)	Ice-cover (11-9 to 12-9) (N=4)	Total (7-26 to 12-9) (N=15)
	Micromhos per centimeter		
C2	79	--	--
C3	73	--	--
CJ	91	122	91
PJ	114	127	117

Table 5--Mean values of nitrogen and phosphorus compounds and silicon in 4 streams, Caribou-Poker Creeks Research Watershed, 7-26-78 to 11-29-78[1]

Station and sample size	NO_2	$NO_2 + NO_3 - N$	$NH_3 - N$	$PO_4 - P$	Si
	Micrograms per liter				Milligrams per liter
C2, N=10	0.55 (0.62)	245.71 (159.95)	40.75 (28.29)	8.49 (7.17)	2.18 (1.76)
C3, N=11	.41 (.52)	286.25 (153.86)	16.04 (11.76)	2.34 (2.16)	1.96 (1.34)
CJ, N=12	.85 (.92)	236.79 (104.99)	35.58 (38.01)	3.36 (3.51)	2.18 (1.24)
PJ, N=14	.84 (.89)	255.71 (119.87)	28.23 (22.27)	4.38 (5.40)	2.17 (1.02)

[1]Standard deviations in parentheses.

Mean phosphate concentrations from C2 appeared to be nearly four times that of C3 and twice the levels in Caribou (CJ) and Poker Creeks (PJ). Small sample sizes from this data set precluded valid statistical testing. Nitrate plus nitrite levels appeared similar at all stations. The low concentrations of nitrite may be attributed to the high dissolved-oxygen content and cold temperatures of the basin (Lotspeich et al. 1976).

Silicon concentrations appeared negtively correlated with discharge at C2, C3, and CJ, but not in Poker Creek. Additional high-discharge measurements will be required to test these relationships further in subsequent study years.

Nitrogen to phosphorus ratios (N/P) are an important consideration in determining limitation of prime nutrients for algal and aquatic plant productivity. N/P ratios were calculated by the formula (Zison et al. 1977):

$$N/P = \frac{\text{Total N}}{\text{Ortho-PO}_4} .$$

N/P ratios greater than 15 are indicative of phosphorus-limited conditions and less than 15 are indicative of nitrogen limitation (Uttormark et al. 1974). Calculated N/P ratios are summarized in table 6. Only two instances of possible nitrogen limitation were evident from the Caribou Creek collections: C2 on 8-9-78 (N/P = 6.5) and 8-16-78 (N/P = 5.6). One case of slight nitrogen limitation occurred in the Poker Creek sampling on 8-9-78 (N/P = 13.2).

Table 6--Nitrogen to phosphorus ratios for 4 streams, Caribou-Poker Creeks Research Watershed

	Station			
Date (1978)	C2	C3	CJ	PJ
7-26	--	27.1	59.5	69.0
8-1	15.3	46.9	--	42.2
8-9	6.5*	166.4	16.1	13.2*
8-16	5.6*	70.8	78.8	18.1
8-23	18.1	108.8	63.4	122.9
8-31	64.5	213.0	104.7	+
9-7	+	+	143.9	+
9-13	143.6	96.1	31.5	60.5
9-20	97.3	820.8	686.8	58.0
9-28	16.6	107.6	--	24.0
10-4	397.4	+	181.2	+
11-7	--	--	187.1	474.3
11-21	--	--	+	+
11-28	--	--	81.2	212.7

* = Nitrogen limited; + = PO_4 - P less than 1.0 milligram per liter.

Consideration of N/P ratios and phosphorus limitation could become relevant if impoundments were proposed on a subarctic lotic system. Examination of these limited data suggest that impounded water from these streams might be phosphorus-limited and thus have a low potential for disruptive or toxic algal blooms, unless landscape disturbance contributed additional phosphorus compounds. Addition of phosphorus from activities such as residential development, roadbuilding, fire, timber harvest, or other manipulations could conceivably supply adequate phosphorus for excessive algal or aquatic plant growth.

Preliminary analyses of these data indicate that assignment of nutrient and sediment loadings will require several years more observations at a greater number of sites with extended sampling frequency. Characterization of high-flow regimes and greater resolution of the relation of discharge to sediment are required. Future efforts should incorporate 9 to 11 stations, and emphasize breakup processes and hydrologic extremes (high and low flows).

Analysis of Elements

Dissolved ionic constituents are presented in appendix table 18. Mean concentrations of dissolved ionic constituents appeared lower in the two first-order streams (C2 and C3) than in the higher order streams (PJ and CJ) (table 7). Ionic concentrations in Poker and Caribou Creeks tended to increase in the autumn after an ice cover had formed; this relationship was also observed in the total hardness concentrations (table 8). Total hardness values are presented in appendix table 19. More samples from higher discharge periods are required to explore further the relation of hardness to discharge.

Table 7--Mean concentrations of elements in 4 streams, Caribou-Poker Creeks Research Watershed

Season (1978), sample size, and station	Na	K	Ca	Mg	As	Fe	Mn
			Milligrams per liter				
Open-water (8-16 to 10-5) (N=7):							
C2	1.49	0.47	8.85	2.80	<0.04	0.016	<0.005
C3	1.52	.43	9.81	1.53	<.04	.56	<.005
CJ	2.01	.72	15.05	3.03	<.04	.105	.015
PJ	2.10	.80	21.51	4.02	.04	.059	.028
Ice-cover (11-9 to 12-9) (N=4):							
CJ	2.01	.77	17.60	3.62	<.04	.056	.022
PJ	1.95	.82	24.00	4.53	.04	.024	.031
Total (8-16 to 12-9) (N=11):							
CJ	2.01	.72	15.05	3.03	<.04	.088	.018
PJ	2.05	.81	22.34	4.19	<.04	.047	.029

Table 8--Mean total hardness of water in 4 streams, Caribou-Poker Creeks Research Watershed[1]

Station	Season (1978)		
	Open-water (8-16 to 10-5) (N=7)	Ice-cover (11-7 to 12-9) (N=4)	Total (8-16 to 12-9) (N=11)
	Milligrams per liter		
C2	33.63 (16.99)	--	--
C3	30.87 (14.58)	--	--
CJ	45.88 (7.56)	59.03 (1.93)	50.26 (8.90)
PJ	70.44 (7.21)	78.65 (2.59)	73.18 (7.16)

[1]Standard deviation in parentheses.

Conclusions

Differences in both quantity and quality of water were observed between the streams. The permafrost-dominated (C3) basin exhibited a more pronounced hydrologic response to the three summer storm events than did the relatively permafrost-free (C2) basin. The third-order stream Poker Creek (PJ) had a higher total discharge than did the second-order stream Caribou Creek (CJ). Water temperatures appeared slightly lower in the C3 basin than in the C2 basin and higher in the third-order Poker Creek than in the second-order Caribou Creek. Poker Creek was found to have a significantly ($P<0.05$) higher mean nonfilterable residue than did Caribou Creek, but no significant difference was observed between C2 and C3. No significant differences in turbidity were observed in either Poker Creek vs. Caribou Creek or C2 vs. C3.

Examination of the water-quality data from a partial season indicates that a weekly sampling schedule will provide an adequate general understanding of gross water-quality characteristics under minimum flow conditions. Major hydrologic events, such as spring breakup and summer storm episodes, evidently are the dominant contributors of sediment to the streams (Aldrich and Johnson 1979). Future efforts should focus on these events.

Access to the basins during spring breakup and major storm events is a major problem. A network of automated samplers would permit simultaneous, timed sampling, a sample schedule dependent on discharge conditions, or both (for example, sampling could commence when discharge increases to a predetermined level).

Greater resolution of suspended-sediment concentrations on the rising and falling limbs of a hydrograph is necessary to calculate sediment-discharge relations accurately. Calculation of annual sediment yields also necessitates more intensive episodic monitoring, especially during spring breakup.

Previous efforts to sample stream quality throughout the winter (Lotspeich et al. 1976) indicated that relatively little sediment is produced and that water-quality characteristics are comparatively stable and predictable under an extensive ice cover. Lotspeich et al. (1976) concluded: "It does not appear necessary to continuously monitor water quality parameters from freezing to breakup unless there is some special reason to justify the effort." Grab samples should be collected monthly in winter, when obtainable; however, extensive aufeis in the C3 and, to a lesser extent, the C2 and C4 valleys commonly precludes periodic sampling past January. Time-lapse photography and automated sampling should be attempted to estimate discharge and associated sediment loadings during spring breakup.

Addition of stations at subdrainage C4, the bridge over upper Caribou Creek upstream from the influx of C3, and at "Caribou Main" (the USGS stream-gaging station) will provide a wider data base for the study of the stream continuum from first- through third-order, and of processes associated with increasing stream order. This more comprehensive sampling scheme should provide the strong comparative data set of "baseline" conditions necessary before experimental landscape manipulations are initiated.

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Conversions

U.S. customary units used in this report may be converted to metric units as follows:

Multiply	By	To obtain
foot	0.3048	meter
mile	1.609	kilometer
pound	.4536	kilogram
square mile	2.589	square kilometer
gallon	3.785	liter
cubic foot	.02831	cubic meter

Metric units used in this report may be converted to U.S. customary units as follows:

Multiply	By	To obtain
meter	3.281	foot
kilometer	.6214	mile
kilogram	2.205	pound
square kilometer	.3861	square mile
liter	.2641	gallon
cubic meter	35.31	cubic foot

Appendix

Table 9--Monthly summaries of precipitation, Caribou-Poker Creeks Research Watershed, May-September 1978

Month	Caribou-project (elevation, 230 m)	Caribou Peak trail (elevation, 487 m)	Caribou Peak trail (elevation, 640 m)	Caribou Peak (elevation, 768 m)	Helmers Ridge (elevation, 630 m)
			Millimeters		
May	2.3	2.5	2.5	--	7.6
June	34.6	53.3	63.5	64	45.6
July	33.4	88.9	78.7	35	12.7
August	54.4	66.0	78.7	50	35.5
September	50.5	60.9	58.4	10	58.4

Table 10--Daily precipitation, summer 1978, Caribou-Poker Creeks junction [using Weather-Measure P-501 tipping-bucket gage]

Date	Precipitation		Date	Precipitation	
	Increment	Cumulative total		Increment	Cumulative total
	Millimeters			Millimeters	
4-7	--	--	7-11	1.78	70.33
4-15	0.76	0.76	7-12	13.46	83.79
4-26	2.29	3.05	7-14	.76	84.55
5-1	.25	3.30	7-22	.25	84.80
5-16	1.52	4.82	7-25	6.10	90.90
5-17	.25	5.07	7-26	.25	91.15
5-26	.25	5.32	8-12	.76	91.91
6-1	7.11	12.43	8-14	1.52	93.43
6-6	1.27	13.70	8-15	8.13	101.56
6-10	.25	13.95	8-16	.25	101.81
6-12	.76	14.71	8-20	16.00	117.81
6-13	9.65	24.36	8-21	17.78	135.59
6-15	.76	25.12	8-22	1.02	136.61
6-16	5.59	30.71	8-31	.25	136.86
6-18	.25	30.96	9-5	6.10	142.96
6-19	4.32	35.28	9-6	10.41	153.37
6-20	.25	35.53	9-7	.25	153.62
6-21	2.03	37.56	9-9	.25	153.87
6-22	9.14	46.70	9-12	.25	154.12
6-23	4.32	51.02	9-14	.25	154.37
6-24	2.29	53.31	9-16	2.29	156.66
6-26	2.03	55.34	9-20	1.27	157.93
6-27	3.81	59.15	9-21	2.29	160.22
6-29	.25	59.40	9-22	.25	160.47
6-30	.51	59.91	9-23	1.02	161.49
7-1	2.79	62.70	9-24	5.59	167.08
7-6	4.83	67.53	9-25	18.54	185.62
7-7	1.02	68.55	9-28	1.02	186.64

Table 11--Mean daily streamflow, summer 1978, subdrainage C-2 of Caribou-Poker Creeks Research Watershed [monitored by Parshall flume, Fisher-Porter water-level recorder]

Date	Mean daily streamflow[1/]	Date	Mean daily streamflow[1/]
	Cubic feet per second[2/]		Cubic feet per second[2/]
6-22	0.65	7-22	0.62
6-23	1.45	7-23	.61
6-24	1.41	7-24	.60
6-25	.93	7-25	.59
6-26	.82	7-26	.57
6-2	[3/]1.47	7-27	.54
6-28	1.41	7-28	.52
6-29	.88	7-29	.51
6-30	.80	7-30	.50
7-1	.77	7-31	.48
7-2	.76	8-1	.48
7-3	.73	8-2	.49
7-4	.69	8-3	.47
7-5	.68	8-4	.46
7-6	.72	8-5	.49
7-7	.69	8-6	.50
7-8	.68	8-7	.46
7-9	.66	8-8	.46
7-10	.64	8-9	.45
7-11	.64	8-10	.45
7-12	.80	8-11	.44
7-13	[4/]1.12	8-12	.44
7-14	1.02	8-13	.45
7-15	.81	8-14	.44
7-16	.73	8-15	.46
7-17	.67	8-16	.54
7-18	.64	8-17	.50
7-19	.64	8-18	.44
7-20	.62	8-19	.42
7-21	.62	8-20	.57

Table 11--Mean daily streamflow, summer 1978, subdrainage C-2 of Caribou-Poker Creeks Research Watershed [monitored by Parshall flume, Fisher-Porter water-level recorder] (continued)

Date	Mean daily streamflow[1/]	Date	Mean daily streamflow[1/]
	Cubic feet per second[2/]		Cubic feet per second[2/]
8-21	1.31	9-11	0.50
8-22	.86	9-12	.51
8-23	.65	9-13	.53
8-24	.57	9-14	.53
8-25	.51	9-15	.53
8-26	.51	9-16	.53
8-27	.48	9-17	.52
8-28	.47	9-18	.51
8-29	.47	9-19	.51
8-30	.47	9-20	.51
8-31	.47	9-21	.52
9-1	.46	9-22	.49
9-2	.45	9-23	.49
9-3	.44	9-24	.49
9-4	.44	9-25	[5/]1.11
9-5	.48	9-26	.88
9-6	.72	9-27	.71
9-7	.57	9-28	.64
9-8	.55	9-29	.61
9-9	.52	9-30	.54
9-10	.51	10-1	.49
		10-2	[6/]--

[1/]Each mean daily flow is the mean of 24 hourly values.
[2/]For conversion to metric units, 1.0 cubic foot per second equals 28.32 liters per second.
[3/]Instantaneous peak was 2.18 cubic feet per second.
[4/]Instantaneous peak was 1.63 cubic feet per second.
[5/]Instantaneous peak was 1.66 cubic feet per second.
[6/]Flume and stilling well frozen.

Table 12--Mean daily streamflow, summer 1978, subdrainage C-3 of Caribou-Poker Creeks Research Watershed [monitored by Parshall flume, Fisher-Porter water-level recorder]

Date	Mean daily streamflow[1]	Date	Mean daily streamflow[1]
	Cubic feet per second[2]		Cubic feet per second[2]
6-21	[3]0.80	7-16	.44
6-22	1.48	7-17	.37
6-23	8.05	7-18	.33
6-24	[4]9.89	7-19	.31
6-25	6.31	7-20	.27
6-26	3.52	7-21	.25
6-27	4.23	7-22	.24
6-28	4.70	7-23	.23
6-29	2.61	7-24	.21
6-30	1.78	7-25	.20
7-1	1.31	7-26	.17
7-2	1.66	7-27	.15
7-3	1.35	7-28	.14
7-4	1.00	7-29	.13
7-5	.76	7-30	.12
7-6	.70	8-1	.12
7-7	.66	8-2	.13
7-8	.59	8-3	.12
7-9	.53	8-4	.11
7-10	.47	8-5	.12
7-11	.44	8-6	.13
7-12	.40	8-7	.11
7-13	.37	8-8	.10
7-14	.41	8-9	.09
7-15	.48	8-10	.08
		8-11	.08

Table 12--Mean daily streamflow, summer 1978, subdrainage C-3 of Caribou-Poker Creeks Research Watershed [monitored by Parshall flume, Fisher-Porter water-level recorder] (continued)

Date	Mean daily streamflow[1/]	Date	Mean daily streamflow[1/]
	Cubic feet per second[2/]		Cubic feet per second[2/]
8-12	0.08	9-6	0.65
8-13	.08	9-7	.89
8-14	.07	9-8	.84
8-15	.09	9-9	.74
8-16	.10	9-10	.64
8-17	.09	9-11	.58
8-18	.08	9-12	.56
8-19	.08	9-13	.53
8-20	.12	9-14	.50
8-21	2.25	9-15	.46
8-22	4.35	9-16	.44
8-23	2.42	9-17	.44
8-24	1.66	9-18	.44
8-25	1.25	9-19	.44
8-26	.97	9-20	.44
8-27	.77	9-21	.44
8-28	.68	9-22	.41
8-29	.61	9-23	.40
8-30	.56	9-24	.40
8-31	.51	9-25	.18
9-1	.49	9-26	2.98
9-2	.46	9-27	2.70
9-3	.45	9-28	1.98
9-4	.42	9-29	1.60
9-5	.42	9-30	1.35
		10-1	2.12
		10-2	5/--

1/ Each mean daily flow is the mean of 24 hourly values.
2/ For conversion to metric units, 1.0 cubic foot per second equals 28.32 liters per second.
3/ Half-day record, from 1400 hours 21 June.
4/ Instantaneous peak was 11.13 cubic feet per second.
5/ Flume and stilling well frozen.

Table 13--Mean daily streamflow, Caribou Creek[1/]

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978[2/]
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	12	7.4	5.6	3.5	2.5	2.5	1.5	1.5	3.7	5.9	1.8	3.2
2	11	7.4	5.6	3.5	2.5	2.5	1.5	1.5	6.1	6.1	1.8	3.0
3	10	7.2	5.6	3.5	2.5	2.5	1.5	1.5	5.0	5.2	1.8	3.0
4	11	7.2	5.4	3.5	2.5	2.5	1.5	1.5	4.6	4.3	1.6	2.8
5	11	7.2	5.2	3.5	2.5	2.5	1.5	1.5	3.6	3.9	1.8	3.0
6	10	7.2	5.2	3.0	2.5	2.0	1.5	1.7	3.7	3.9	1.8	4.6
7	9.3	7.0	5.2	3.0	2.5	2.0	1.5	1.9	3.7	3.9	1.8	4.6
8	9.0	7.0	5.0	3.0	2.5	2.0	1.5	2.0	3.4	3.6	1.8	4.1
9	8.4	7.0	5.0	3.0	2.5	2.0	1.5	2.0	3.4	3.2	1.8	3.9
10	8.4	6.8	5.0	3.0	2.5	2.0	1.5	1.6	2.8	3.0	1.8	3.9
11	8.4	6.8	5.0	3.0	2.5	2.0	1.5	1.6	2.5	2.8	1.8	3.6
12	8.2	6.8	5.0	3.0	2.5	2.0	1.5	1.7	2.5	3.2	1.8	3.6
13	8.2	6.6	4.5	3.0	2.5	2.0	1.5	2.0	2.7	4.6	1.8	3.4
14	8.2	6.6	4.5	3.0	2.5	2.0	1.5	2.2	2.8	5.6	1.8	3.4
15	8.2	6.6	4.5	3.0	2.5	2.0	1.5	2.5	2.5	5.0	2.2	3.2
16	8.0	6.6	4.5	3.0	2.5	2.0	1.5	2.4	2.8	3.6	2.2	3.2
17	8.0	6.4	4.5	3.0	2.5	2.0	1.5	2.0	4.3	3.2	2.0	3.4
18	8.0	6.4	4.0	3.0	2.5	2.0	1.5	2.0	3.4	2.8	2.0	3.2
19	8.0	6.4	4.0	3.0	2.5	2.0	1.5	2.0	4.8	2.7	1.8	3.2
20	8.0	6.4	4.0	3.0	2.5	2.0	1.5	2.1	5.9	2.7	2.4	3.0
21	7.8	6.2	4.0	3.0	2.5	2.0	1.5	2.2	3.9	2.5	11	3.0
22	7.8	6.2	4.0	3.0	2.5	2.0	1.5	2.6	5.2	2.4	14	3.0
23	7.8	6.2	4.0	2.5	2.5	2.0	1.5	3.0	19	2.4	8.4	3.0
24	7.8	6.0	4.0	2.5	2.5	2.0	1.5	3.2	23	2.3	6.1	3.0
25	7.8	6.0	4.0	2.5	2.5	2.0	1.5	3.2	14	2.0	4.8	7.1
26	7.6	6.0	4.0	2.5	2.5	1.5	1.5	3.0	9.3	2.0	4.3	9.9
27	7.6	5.8	4.0	2.5	2.5	1.5	1.5	3.0	13	2.0	3.7	7.6
28	7.6	5.8	3.5	2.5	2.5	1.5	1.5	3.2	13	1.8	3.6	6.1
29	7.4	5.8	3.5	2.5	---	1.5	1.5	3.0	8.7	1.8	3.6	5.2
30	7.4	5.8	3.5	2.5	---	1.5	1.5	2.8	7.1	1.6	3.4	4.8
31	7.4	---	3.5	2.5	---	1.5	---	2.8	---	1.8	3.4	---
TOTAL	265.3	196.8	139.3	91.0	70.0	61.5	45.0	69.2	190.4	101.8	103.9	122.0
MEAN	8.56	6.56	4.49	2.94	2.50	1.98	1.50	2.23	6.35	3.28	3.35	4.07
MAX	12	7.4	5.6	3.5	2.5	2.5	1.5	3.2	23	6.1	14	9.9
MIN	7.4	5.8	3.5	2.5	2.5	1.5	1.5	1.5	2.5	1.6	1.6	2.8
CFSM	.93	.71	.49	.32	.27	.22	.16	.24	.69	.36	.37	.44
IN.	1.07	.80	.56	.37	.28	.25	.18	.28	.77	.41	.42	.49
AC-FT	526	390	276	180	139	122	89	137	378	202	206	242

CAL YR 1977 TOTAL 1911.30 MEAN 5.24 MAX 60 MIN .20 CFSM .57 IN 7.74 AC-FT 3790
WTR YR 1978 TOTAL 1456.20 MEAN 3.99 MAX 23 MIN 1.5 CFSM .43 IN 5.89 AC-FT 2890

NOTE.--No gage-height record October 7 to May 23.

1/ From U.S. Geological Survey (1979).
2/ For conversion to metric units, 1.0 cubic foot per second = 28.32 liters per second.

Table 14--Mean daily streamflow, Poker Creek[1/]

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978[2/]
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	28	10	6.0	5.0	4.0	3.5	3.0	18	11	13	7.6	7.2
2	26	10	6.0	5.0	4.0	3.5	3.0	19	14	12	7.6	5.0
3	25	10	6.0	5.0	4.0	3.5	3.0	19	12	11	6.8	5.0
4	24	10	6.0	5.0	4.0	3.5	3.0	20	11	10	6.4	5.0
5	23	9.0	6.0	5.0	4.0	3.5	4.0	20	10	8.4	6.8	6.0
6	22	9.0	6.0	5.0	4.0	3.5	4.0	19	10	10	12	13
7	21	9.0	6.0	5.0	4.0	3.5	5.0	19	9.0	11	10	12
8	20	9.0	6.0	5.0	4.0	3.5	5.0	18	9.0	10	8.8	11
9	20	9.0	6.0	5.0	4.0	3.0	6.0	17	8.0	8.8	8.0	9.6
10	19	9.0	6.0	5.0	4.0	3.0	7.0	16	8.0	8.0	6.8	8.8
11	19	8.0	5.5	4.5	4.0	3.0	7.0	15	7.0	7.6	6.0	8.4
12	18	8.0	5.5	4.5	4.0	3.0	7.0	14	7.0	9.2	6.0	8.4
13	18	8.0	5.5	4.5	3.5	3.0	7.0	13	7.0	14	6.0	8.4
14	17	8.0	5.5	4.5	3.5	3.0	8.0	13	7.0	15	6.4	8.4
15	17	8.0	5.5	4.5	3.5	3.0	8.0	14	7.0	12	8.0	8.4
16	16	8.0	5.5	4.5	3.5	3.0	8.0	16	8.0	11	8.4	8.8
17	16	8.0	5.5	4.5	3.5	3.0	8.0	17	9.0	9.2	8.0	9.2
18	15	7.0	5.5	4.5	3.5	3.0	8.0	16	10	8.8	6.8	8.8
19	15	7.0	5.5	4.5	3.5	3.0	8.0	15	12	8.0	6.0	8.4
20	14	7.0	5.5	4.5	3.5	3.0	8.0	15	11	7.2	7.2	8.4
21	14	7.0	5.5	4.5	3.5	3.0	9.0	14	10	8.0	25	8.4
22	13	7.0	5.5	4.5	3.5	3.0	9.0	14	9.0	7.6	26	8.4
23	13	7.0	5.5	4.5	3.5	3.0	10	13	15	7.2	19	8.4
24	12	7.0	5.0	4.5	3.5	3.0	10	13	20	7.2	16	8.8
25	12	7.0	5.0	4.5	3.5	3.0	11	12	18	10	13	20
26	12	6.0	5.0	4.0	3.5	3.0	12	12	20	15	12	29
27	11	6.0	5.0	4.0	3.5	3.0	14	13	23	14	11	22
28	11	6.0	5.0	4.0	3.5	3.0	15	12	20	12	9.6	18
29	11	6.0	5.0	4.0	---	3.0	16	11	17	10	9.2	16
30	10	6.0	5.0	4.0	---	3.0	17	10	15	8.8	8.8	14
31	10	---	5.0	4.0	---	3.0	---	10	---	8.0	8.0	---
TOTAL	522	236.0	171.5	141.5	104.0	97.0	243.0	467	354.0	312.0	307.2	321.2
MEAN	16.8	7.87	5.53	4.56	3.71	3.13	8.10	15.1	11.8	10.1	9.91	10.7
MAX	28	10	6.0	5.0	4.0	3.5	17	20	23	15	26	29
MIN	10	6.0	5.0	4.0	3.5	3.0	3.0	10	7.0	7.2	6.0	5.0
CFSM	.73	.34	.24	.20	.16	.14	.35	.65	.51	.44	.43	.46
IN.	.84	.38	.28	.23	.17	.16	.39	.75	.57	.50	.49	.52
AC-FT	1040	468	340	281	206	192	482	926	702	619	609	637

CAL YR 1977	TOTAL	4142.70	MEAN 11.3	MAX 70	MIN .70	CFSM .49	IN 6.67	AC-FT 8220
WTR YR 1978	TOTAL	3276.40	MEAN 8.98	MAX 29	MIN 3.0	CFSM .39	IN 5.28	AC-FT 6500

NOTE.--No gage-height record Oct. 5 to June 28.

1/From U. S. Geological Survey (1979).
2/For conversion to metric units, 1.0 cubic foot per second = 28.32 liters per second.

Table 15--Air and water temperature, pH, alkalinity, and specific conductance for streamwater-monitoring stations, Caribou-Poker Creeks Research Watershed, 1978

Station	Date	Time	Air temperature	Water temperature	pH	Bicarbonate alkalinity	Specific conductance
			- - - - - - °C - - - - -			Milligrams per liter	Micromhos per square centimeter
C1	9-12	1200	3	3.5	7.6	35	46
C2	7-26	1220	24	5	7.8	--	86
	8-1	1200	25	5	7.6	--	80
	8-9	1200	28	6.5	7.0	--	83
	8-16	1145	21	5	7.0	--	73
	8-23	1130	12	4	7.1	35	82
	8-31	1130	22	4	8.2	35	86
	9-7	1130	17.5	4	7.9	35	77
	9-13	1100	3	4	7.7	35	73
	9-20	1200	2	2.5	7.9	39	74
	9-28	1150	12	2.5	7.5	39	77
	10-4	1100	-7	0	8.0	54	82
C3	7-26	1325	23	3.5	7.9	--	95
	8-1	1230	25	4.5	7.7	--	93
	8-9	1230	28	5.5	7.0	--	--
	8-16	1215	21	5	7.1	--	84
	8-23	1200	12	2.5	7.1	18	53
	8-31	1200	20	3	8.2	38	73
	9-7	1200	18	2.5	7.9	32	69
	9-13	1300	4	3	7.6	27	65
	9-20	1230	2	1.5	8.2	32	73
	9-28	1230	12	1	7.6	26	52
	10-4	1130	-7	0	7.6	31	77
C4	9-13	1445	4	3	8.0	56	95
	11-21	1100	-6	0	8.0	55	108
CJ	7-26	1500	21	6	8.0	--	97
	8-1	1315	25	--	7.4	--	108
	8-9	1315	27	7	7.9	--	99
	8-16	1300	18	7	7.2	--	92
	8-23	1100	12	3	7.1	35	69
	8-31	1245	19	3.5	8.0	76	95
	9-7	1130	17	2	8.0	58	86
	9-14	0930	3	2	8.1	46	86
	9-20	1200	5	2	7.8	50	95
	9-27	1145	12	1.5	8.2	20	82
	10-4	1300	-7	0	7.7	45	95
	11-9	1345	-19	0	7.9	60	112
	11-21	1200	-6	0	8.2	49	112
	11-28	1200	-10	0	8.1	45	120
	12-8	1200	-6	0	7.3	56	142
P1	9-12	1430	4	4	7.9	62	112
P2	9-12	1500	4	4	8.1	48	112
P4	9-12	1630	3	2	7.9	55	86
P6	9-12	1830	3	3	7.8	55	120
PJ	7-26	1555	--	--	8.3	--	112
	8-1	1330	25	--	7.3	--	129
	8-9	1330	27	10	7.8	--	116
	8-16	1315	18	7	7.2	--	116
	8-23	1130	12	4	7.0	50	103
	8-31	1300	19	6	7.9	62	112
	9-7	1200	17	4	8.1	62	112
	9-14	1015	3	3	8.0	60	120
	9-20	1215	5	3	8.1	54	116
	9-27	1200	12	2.5	8.0	44	95
	10-4	1300	-7	0	7.8	58	120
	11-9	1400	-19	0	7.8	62	146
	11-21	1230	-6	0	8.2	72	108
	11-28	1230	-10	0	8.2	63	97
	12-8	1200	-6	0	7.2	59	155

Table 16--Nonfilterable residue, turbidity, and point discharge, for streamwater-monitoring stations, Caribou-Poker Creeks Research Watershed, 1978

Date	Nonfilterable residue	Turbidity	Discharge	Nonfilterable residue	Turbidity	Discharge
	Milligrams per liter	Formazin turbidity units	Cubic feet per second	Milligrams per liter	Formazin turbidity units	Cubic feet per second
		STATION C2			STATION C3	
5-16	0.16			0.12		
5-22	.08			1.24		
5-30	.04			.08		
6-9	.08			.16		
6-14	0			.08		
6-21	.06		0.56	.12		0.84
6-28	.96		1.37	.22		4.69
7-6	.04		.76	.04		.70
7-12	.36		.70	0		.39
7-18	.08		.67	--		.35
7-26	.53	0	.62	.10	0	.20
8-1	.59	2	.49	0	2	.12
8-9	.32	2	.46	.13	2	.08
8-16	0	8	.67	.18	2	.10
8-23	0	2	.64	.26	7	2.39
8-31	.02	0	.49	.40	0	.51
9-7	.08	0	.54	0	2	.94
9-13	0	0	.54	0	0	.56
9-20	1.74	2	.51	1.50	0	.44
9-28	0	8	.73	0	5	2.75
10-4	0	0	1/--	0	3	1/--
		STATION C1			STATION C4	
9-13	--	0	--	--	0	.9
11-21	--	--	--	--	7	--
		STATION P1			STATION P2	
9-12	--	0	3.0	--	0	.9
		STATION P4			STATION P6	
9-12	--	0	1.35	--	0	--
		STATION CJ			STATION PJ	
6-21	.80		3.9	1.72		10
6-23	61.20		19	58.73		15
6-26	3.92		9.2	32.68		20
6-27	2.40		13	22.72		23
6-28	5.16		13	10.92		17
6-29	2.44		8.7	8.76		17
6-30	1.00		7.1	--		15
7-6	.60		3.9	7.36		15
7-10	1.64		3.0	6.20		10
7-11	2.28		2.8	23.52		8.0
7-12	.83		3.2	5.70		9.2
7-13	15.28		4.6	14.12		14
7-14	3.88		5.6	13.28		15
7-18	1.93		2.8	14.12		8.8
7-19	2.69		2.7	47.16		8.0
7-20	1.24		2.7	14.02		7.2
7-21	1.97		2.5	10.84		8.0
7-26	.59	7	2.0	22.24	8	15
8-1	.74	3	1.8	4.75	3	7.6
8-9	.61	7	1.8	2.87	5	8.0
8-16	.02	5	2.2	.66	4	8.4
8-23	1.14	15	8.4	.94	10	19
8-31	.24	0	3.4	.12	0	8.0
9-7	.09	10	4.6	.47	5	12
9-14	.32	0	3.4	.54	0	8.4
9-20	2.26	4	3.0	2.50	6	8.4
9-27	.71	15	7.6	2.95	9	18
10-4	.04	4	2/--	.24	4	2/--
11-9	.26	0		.08	0	
11-21	.32	2		.04	8	
11-28	0	9		0	9	
12-8	0	0		.20	0	

1/Frozen.
2/Terminated.

Table 17--Water chemistry data for streamwater-monitoring stations, Caribou-Poker Creeks Research Watershed, 1978

Station	Date	NO_2 - N	NO_2+NO_3 - N	NH_3 - N	PO_4 - P	Si
		Micrograms per liter				Milligrams per liter
C2	7-26	--	--	--	--	--
	8-1	1.3	220.5	20.7	15.8	3.75
	8-9	1.3	32.2	34.5	10.2	.40
	8-16	<1.0	32.2	77.0	19.5	.37
	8-23	<1.0	130.3	26.3	8.7	<.01
	8-31	1.4	212.1	27.7	3.7	3.71
	9-7	<1.0	432.1	98.5	<1.0	3.75
	9-13	<1.0	453.1	36.4	3.4	3.62
	9-20	<1.0	460.7	25.8	5.0	3.83
	9-28	<1.0	242.6	55.4	18.0	.02
	10-4	<1.0	241.3	5.0	<1.0	2.37
C3	7-26	<1.0	141.8	43.0	6.8	2.54
	8-1	<1.0	140.1	5.2	3.1	3.27
	8-9	<1.0	139.0	15.8	<1.0	3.27
	8-16	<1.0	134.6	19.0	2.2	1.20
	8-23	<1.0	329.2	8.3	3.1	.04
	8-31	1.4	182.8	15.3	<1.0	1.51
	9-7	<1.0	542.2	21.4	<1.0	3.60
	9-13	<1.0	460.7	16.1	5.0	.40
	9-20	<1.0	482.8	26.1	<1.0	3.50
	9-28	<1.0	332.4	1.3	3.1	.48
	10-4	<1.0	263.3	5.0	<1.0	1.79
CJ	7-26	2.4	118.9	10.2	2.2	4.20
	8-1	--	--	--	--	--
	8-9	<1.0	143.0	21.8	10.2	4.22
	8-16	<1.0	134.9	11.8	1.9	2.59
	8-23	1.1	174.4	22.1	3.1	.55
	8-31	<1.0	122.1	40.2	1.5	3.40
	9-7	<1.0	275.0	37.4	2.2	1.53
	9-14	<1.0	315.4	16.5	10.5	.82
	9-20	2.8	276.4	149.5	<1.0	1.01
	9-27	--	--	--	--	--
	10-4	<1.0	161.2	7.3	<1.0	2.15
	11-7	<1.0	361.1	44.8	2.2	1.41
	11-21	<1.0	383.4	38.1	<1.0	2.33
	11-28	<1.0	375.7	27.2	5.0	1.95
PJ	7-26	2.0	138.5	11.2	2.2	3.71
	8-1	2.4	117.0	24.1	3.4	3.60
	8-9	<1.0	161.2	38.9	15.2	1.01
	8-16	1.8	125.4	15.0	7.7	1.31
	8-23	1.1	174.2	16.2	1.5	2.61
	8-31	<1.0	138.9	10.2	<1.0	1.08
	9-7	<1.0	294.3	19.5	<1.0	3.60
	9-14	<1.0	313.6	23.8	5.6	2.37
	9-20	<1.0	335.3	41.7	6.5	2.82
	9-27	2.0	292.6	93.6	16.1	2.67
	10-4	<1.0	197.5	7.4	<1.0	1.01
	11-7	<1.0	423.9	17.2	<1.0	1.02
	11-21	<1.0	437.6	44.7	<1.0	1.77
	11-28	<1.0	429.9	31.7	2.2	1.79

Table 18--Dissolved ionic constitutents for streamwater-monitoring stations, Caribou-Poker Creeks Research Watershed, 1978

Station	Date	Na	K	Ca	Mg	As	Fe	Mn
				Milligrams per liter				
C2	8-16	1.1	0.4	7.5	1.6	<0.04	0.005	0.007
	8-23	<.1	<.1	<.1	<.1	<.04	<.005	<.005
	8-31	3.0	.8	11.3	3.7	<.04	<.005	<.005
	9-7	.8	.2	4.8	1.6	<.04	<.005	<.005
	9-13	1.2	.6	11.9	3.9	<.04	.013	<.005
	9-20	1.4	.7	11.8	3.9	<.04	.020	<.005
	9-28	2.2	.5	11.7	3.8	<.04	.007	<.005
	10-4	2.1	.5	11.7	3.8	<.04	.005	<.005
C3	8-16	.4	.2	4.1	<.1	<.04	<.005	<.005
	8-23	.2	<.1	2.1	<.1	<.04	<.005	<.005
	9-7	2.3	.5	11.2	1.9	<.04	.170	<.005
	9-13	1.4	.6	12.5	2.0	<.04	.090	<.005
	9-20	1.6	.6	13.1	2.2	<.04	.130	<.005
	9-28	2.1	.4	9.6	1.6	<.04	.037	<.005
	10-4	1.6	.4	12.6	2.1	<.04	.005	<.005
CJ	8-16	1.1	.4	11.9	1.6	<.04	.030	.013
	8-23	2.4	.6	11.5	2.4	<.04	.202	.016
	8-31	2.6	.8	15.3	3.1	<.04	.078	.017
	9-7	2.4	.8	13.6	2.9	<.04	.135	.020
	9-14	1.6	.8	15.5	3.2	<.04	.074	.011
	9-20	2.2	1.1	15.8	3.2	<.04	.089	.020
	9-27	2.2	.5	10.6	2.3	<.04	.151	.007
	10-4	1.8	.5	16.0	3.2	<.04	.078	.020
	11-9	2.0	.9	16.7	3.5	<.04	.049	.025
	11-21	2.0	.8	18.0	3.6	<.04	.055	.013
	11-28	2.0	.7	17.7	3.6	<.04	.062	.026
	12-8	1.8	.7	18.0	3.8	<.04	.058	.025
PJ	8-16	3.3	1.2	23.0	4.4	<.04	.057	.042
	8-31	2.4	.8	21.5	4.0	<.04	.037	.033
	9-7	2.4	.8	21.4	4.0	<.04	.079	.031
	9-12	1.6	.8	25.0	3.9	<.04	.030	.007
	9-14	1.5	.8	22.0	4.2	<.04	.058	.028
	9-20	1.6	.8	22.0	4.3	<.04	.045	.035
	9-27	2.2	.6	16.4	3.2	<.04	.114	.008
	10-4	1.8	.6	20.8	4.2	<.04	.053	.038
	11-9	1.7	.7	24.0	4.6	<.04	.018	.032
	11-21	2.0	.8	23.0	4.3	<.04	.023	.024
	11-28	1.8	.8	24.0	4.6	<.04	.018	.032
	12-8	2.3	1.0	25.0	4.6	<.04	.037	.037
C1	9-13	1.0	.5	9.0	1.9	<.04	.220	<.005
C4	9-13	1.6	.8	17.6	3.3	<.04	.012	.007
C4	11-21	2.0	.8	18.1	3.5	<.04	.015	<.005
P1	9-12	1.2	.8	24.0	4.7	<.04	.030	.006
P2	9-12	1.1	.6	17.9	4.8	<.04	.005	<.005
P4	9-12	1.5	.7	16.2	2.5	<.04	.077	.016

Table 19--Calculated total hardness for streamwater-monitoring stations, Caribou-Poker Creeks Research Watershed, 1978

Date	Station			
	C2	C3	CJ	PJ
	Milligrams per liter			
8-16	25.34	10.65	36.37	75.72
8-23	.56	6.65	38.99	70.28
8-31	43.45	42.28	51.13	70.10
9-7	18.58	36.09	46.18	78.54
9-13	45.78	39.60	52.02	72.37
9-20	45.55	42.00	62.82	72.77
9-28	44.86	30.63	36.22	54.33
10-4	44.85	40.10	53.30	69.39
11-9	--	--	56.25	78.95
11-21	--	--	59.89	75.21
11-28	--	--	59.18	78.95
12-8	--	--	60.74	81.50